PB-242 443

MONOGRAPH OF THE EFFECTIVENESS AND COST OF WATER TREATMENT PROCESSES FOR THE REMOVAL OF SPECIFIC CONTAMINANTS. VOLUME II, KWIK INDEX

DAVID VOLKERT AND ASSOCIATES

PREPARED FOR
ENVIRONMENTAL PROTECTION AGENCY

AUGUST 1974

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U. S. DEPARTMENT OF COMMERCE

BIBLIOGRAPHIC DATA SHEET	1. Report No. 430/9-75-008	2.	PB 242 443

4. Title and Subtitle
Monograph on the effectiveness and cost of water treatment processes for the removal of specific contaminants. Volume I Technical Manual Volume II Kwik Index

5. Report Date Publishes August 1974

6.

7. Author(s) Ian C. Watson, Stephen J. Spano, Howard N. Davis Frederick M. Heider

8. Performing Organization Rept. No.

9. Performing Organization Name and Address
Environmental Planning and Engineering
Division of David Volkert & Associates
4701 Sangamore Rd.
Bethesda, Md. 20016

10. Project/Task/Work Unit No.

11. Contract/Grant No.
68-01-1833

12. Sponsoring Organization Name and Address
Environmental Protection Agency
Water Supply Division
401 M St., S.W.
Washington, D.C. 20460

13. Type of Report & Period Covered
Final

14.

15. Supplementary Notes

16. Abstracts
The monograph provides information on treatment processes for potable water supplies and their costs. It is intended as a general planning document, giving the user general concepts on what treatment methods are available to remove specific contaminants or reduce them below the limits required or recommended by the 1974 Federal Drinking Water Standards and Guidelines. These contaminants may be physical, biological radioligical, or chemical. General cost estimates for the removal or reduction of contaminant levels can be made by using the cost estimation curves and procedures outlined in the monograph. Volume II of the monograph is a KWIK INDEX which provides additional references for more detail information or treatments and costs.

17. Key Words and Document Analysis. 17a. Descriptors

Water Treatment
Potable Water
Cost Estimates
Effectiveness

17b. Identifiers/Open-Ended Terms

17c. COSATI Field Group

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NATIONAL TECHNICAL
INFORMATION SERVICE
US Department of Commerce
Springfield, VA. 22151

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
Release Unlimited	UNCLASSIFIED	82
	20. Security Class (This Page) UNCLASSIFIED	22. Price $4.75

MONOGRAPH OF THE EFFECTIVENESS AND COST OF WATER TREATMENT PROCESSES FOR THE REMOVAL OF SPECIFIC CONTAMINANTS

Volume II
KWIK INDEX

by

Environmental Planning and Engineering
a division of
David Volkert & Associates
4701 Sangamore Road
Bethesda, Maryland 20016

for the

OFFICE OF
AIR AND WATER PROGRAMS

WATER SUPPLY BRANCH

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Contract #68-01-1833

June 1974

EPA Review Notice

This report has been reviewed by EPA, and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

ABSTRACT

This monograph provides information on treatment processes for potable water supplies and their costs. It is intended as a general planning document, giving the user general concepts on what treatment methods are available to remove specific contaminants or reduce them below the limits required or recommended by the 1974 Federal Drinking Water Standards and Guidelines. These contaminants may be physical, biological, radiological, or chemical. General cost estimates for the removal or reduction of contaminant levels can be made by using the cost estimation curves and procedures outlined in the monograph. Volume II of the monograph is a KWIK INDEX which provides additional references for more detailed information on treatments and costs.

This report was submitted in fulfillment of EPA contract 68-01-1833 under the sponsorship of the Water Quality Office, Environmental Protection Agency.

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INTRODUCTION

The KWIK INDEX is designed to allow the user of the Monograph to refer to an original information source. It is divided into 3 sections: reference, subject, and author.

The Reference Section is organized numerically. To find a source in this section of the KWIK INDEX, one would be referred by the Monograph (see page 7, Vol. I). The Subject Section allows the reader to find the appropriate reference if he knows the subject. It is cross-referenced to the Reference Section by number and page. The Author Section allows the reader to locate a reference if only the author is known. It is cross-referenced to the Reference Section by number.

Example

If a reader wants to find a reference regarding arsenic removal, he would refer to the Subject Section under the heading of Arsenic. The reader would find the specific reference, "Arsenic Removal from Potable Water", Journal AWWA 63:7:454. The user would also note that this same reference is listed as #27 in the Reference Section on page 11. On page 11, Reference Section, the reader will find a short synopsis of the article, the author, date of publication, plus a listing of key words.

Disposal of Alum Sludges,
Journal AWWA, 64.1.46

Albrecht, A.E,

January 1972

Now that environmental protection is receiving increasing attention, it is becoming imminently necessary to find alternative methods for disposing of water-treatment-plant sludge. The author briefly reviews the technology of the field and then analyzes the significance of laboratory tests conducted to determine optimum disposition.

water treatment plant sludge disposal laboratory test

00001

Mercury in Drinking Water Supplies
Journal AWWA, 64.1.60

Hammerstrom, R.J., et al,

January 1972

Results of the EPA Div. of Water Hygiene's analyses for mercury in 698 samples of raw and finished waters collected from 273 drinking water supplies throughout the US indicate no health hazard, but point up a need for continuing surveillance.

mercury surveillance analyses

00002

Reservoir Renovation: Butyl-Rubber Lining and Floating Cover,
Journal AWWA 65.2.151

Frazer, Stanley J.

Feb. 1973

When the City of Erie, Pa., decided to cover an open reservoir in its distribution system, many practical decisions had to be made. The author traces the planning and construction of the project and discusses subsequent gains problems, and recommendations.

open reservoir cover construction recommendations

00003

Replication Modeling for Water-Distribution Control,
Journal AWWA 65.4.255.

Gilman, Harold D., et al.

April, 1973

When a computer makes decisions about the control of a water distribution system, it must first replicate and then evaluate field status on the basis of very limited field monitoring date. Here are some approaches to replication modeling and the problems associated with each.

water distribution computer control

00004

Control of Reservoir Euthrophication.
Journal AWWA, 65.4.268,

Eunpu, Floyd, F.

April 73

The Fairfax County Water Authority has used water aeration to advantage and had there by eliminated a taste and odor problem. The article contains results of water quality tests before and after treatment.

aeration taste odor tests results

00005

Magnesium Carbonate - A Recycled Coagulant,
Journal AWWA 64 1 11

Thompson C.G. Singley, J.E. Black A.P.

January 1972

Most treatments for coagulation now in vogue leave the water-treatment operator with a potential pollution problem. The authors describe their laboratory work with the use of a coagulant

that can be recycled and, moreover, that permits the operator greater latitude in doctoring the water's qualities in order to minimize potential corrosion problems. This is the first of two articles. Next month the Journal will present the second installment, which will discuss the economic aspect.

coagulation magnesium-carbonate recycled

00006

Magnesium Carbonate - A Recycled Coagulant,
Journal AWWA, 64.1.11.

Thompson G. Singley, J.E. Black A.P.

January 1972

Part 1, last month, detailed the use of magnesium carbonate for the coagulation of organic color and turbidity in both natural and synthetic waters and dealt primarily with the laboratory evaluations and the results of these studies. This article discusses the economic evaluation of this new process, some of the theoretical relationships derived, and its application to in-plant use.

coagulation magnesium-carbonate color turbidity

00007

Ozone Practices in France,
Journal AWWA. 64.1.39

Gomella, Cyril,

January 1972

Ozone has been used in France for disinfecting water for nearly three quarters of a century. Within the last decade researchers in that country have come to understand optimum treatment techniques. The article explains the principles of ozonation and outlines the advantages ozonation versus other treatment.

ozone disinfecting principles France

00008

Growth of Desalting Technology - Studies and Applications,
Journal AWWA. 64.11.701

Strobel, Joseph J.

November, 1972

Cooperative studies of the Office of Saline Water with federal, state, and municipal agencies engaged in water supply planning are adding to the knowledge about potential applications of desalting. Information is being gathered on short-range possibilities for small desalting plants as well as possible large-scale applications to assist in solving longer-range water-supply needs. Projections of overall desalting requirements in US regions having fresh-water shortages are given.

desalting applications requirements

00009

Improving Community Water Supplies with Desalting Technology,
Journal AWWA. 64.11.705

Faber, H.A. Bresler, S.A. Walton, G.

November. 1972

The aim of the AWWA Research Foundation in this study is to evaluate major desalting techniques electrodialysis, Ion-exchange and reverse osmosis. Emphasis is on methods of providing the public with economical, high quality water.

desalting RO Ix electrodialysis community water

00010

Membrane and Ion-Exchange processes- A Review.
Journal AWWA, 64.11.711

Lynch, M.A. Mintz M.S.

Nov, 1972

This article discribes the history and developement of Reverse Osmosis, Ion Exchange and Electrodialysis, including advantages and disadvantages for each system. Other topics dealt with include cost data, processes in use and systems descriptions.

Ix R O electrodialysis costs description

00011

Secondary- Refrigerant Desalination.
Journal AWWA 64.11.746

Fraser,J.H. Gibson, W.E.

November, 1972

Freezing processes for the desalination of water have been under development for about 20 years. this article deals with new approaches that differ significantly from previous conceptions and allow development of an advanced commercially viable process. These innovations include a pressurized wash column; a small, high-capacity crystallizer; indirect -contact melting; and use of a nontoxic, nonflammable fluorocarborn refrigerant.

desalination freezing innovations

00012

Economics of Ion-Exchange Techniques for Municipal Water-Quality Improving,
Journal AWWA 6.11.764

Bresler, S.A. Miller, E.P.

Nov. 1972

Preliminary investigations indicate that modified ion- exchange processes or combined ion-exchange and membrane processes may be competitive with electrodialysis and reverse osmosis in improving the quality of some brackish municipal water supplies. These processes are described and a cost methodology is presented.

Ix R C electrodialysis costs

00013

Desalting as a Source of Water Supplies,
Journal AWWA, 64.12.804

Miller, E.F.

December 1972

The Office of Saline Water has been entrusted by Congress to provide for development of economical means of converting sea and brackish waters to a quality suitable for municipal, industrial, and agricultural use as well as to determine water demineralization costs by the leading desalting processes compared with other means of providing water. The article outlines some of the progress and findings of the office of Saline Water.

desalting sea brackish economical findings

00014

Selecting a Softening Process
Journal AWWA, 64.12.820

Wood, Frank C,

December 1972

The article contains results of a survey of randomly selected lime-soda ash and zeolite plants, which show that zeolite plants are normally installed when capacities of less than 5 mgd are required. However, chemical costs and the composition of the water may make zeolite plants with capacities of 10 mgd desirable and economical. Charts and examples are given for calculating exact chemical costs to be added to plant costs to determine the system indicated.

softening lime-soda zeolite costs

00015

Special Lake Water Treatment Problems,
Journal AWWA, 64.9.585.

Vaughn, James C.

Sept 1972

The author recounts some of the problems encountered by Chicago's two filtration plants in keeping waters flowing to them. The problems mentioned include, needle ice clogging plant intakes, small fish known as alewives clogging intakes; algae and plankton forming mats on filters; taste and odor producing microorganisms; and problems with winter time diatoms forming mats on filters and raising the pH level to 9.1. Use of chlorination and activated carbon to remove micro organisms explained. Mats were broken up with surface wash and removed with backflushing. Wintertime diatoms were controlled with increased coagulation.

treatment lake clogging intakes activated-carbon

00016

The Necessity of Controlling Bacterial Populations in Potable Waters: Community Water Supply.
Advanced Wastewater Treatment for Removing Nitrogen and Phosphorus.

Geldreich, E.E Nash, H.D Reasoner D.J. Taylor R.H.,.

The waters in some of the community water supply systems in the US often contain a myriad of micro organisms that carry past the disinfection barrier. Although the majority of those that survive are not pathogenic, the situation presents a potential danger. Here is an article on the sort of organisms that contribute to the trouble, with a description of factors relating to propagation of the species.

micro-organisms disinfection barrier danger

00017

High-Rate Filtration,
Journal AWWA, 64.3.157,

Jones, W.H. Kirchman, W.L.

March 1972

Acceptable operation of a high-rate filtration plant depends on the right equipment and a design that permits sufficient flexibility. After defining their prerequistes for high-rate operation, the authors proceeded to detail a system that fulfills these prerequisites.

filtration high-rate prerequisites

00018

Practical Aspects of Tank Design,
Journal AWWA, 64.3.16.

Hoedeman, K A.

March 1972

Standpipes have long been built according to established standards, and their durability and long life prove the wisdom of these standards. But the author believes that new tanks can be safely built outside those standards, if close cooperation between water suppliers, designers, manufacturers and users is realized.

standpipes standards new ccoperation

00019

Granular Carbcn Filters for Taste and Cdor Removal,
Journal AWWA, 64.3.176

Hanse, Robert E. Lackey, Robert T.

March 1972

Three years experience with granular carbon filters has been successful at Mt. Clemens, Mich., in producing water entirely free of tastes and odors. System replaced sand filtration in previous use, Article outlines degree of success problems encountered and recommends future testing cf granular carbon. In addition to taste and odor removal all organics, detergents, and pesticides were apparently removed.

filters carbons granular tastes odor organics

00020

Artificial Reservcir Destratification Effects on Phytoplankton, Mixing Coagulation and Sedimentation
Journal WPCF, Vol.45, no.4, p.669. Water Works Manual and Catalog File, 1970, p.9.

April, 1973

Contrclling phytoplankton blooms that characteristically develop in the epilimnion cf scme reservoirs would be beneficial to many water users. As a potential solution to this problem, efforts have been made to eliminate blcoms or at least reduce their severity with thermal destratification. The study area (Parvin Lake, Colorado) methods and results are presented in this study. Equipment and processes for mixing, coagulation and sedimentation in the treatment of municipal water are described in detail in this chapter.

destratification reservoir phytoplankton

00021

Water Pollution Aspects of Streets Surface Contaminants,
U.S. EPA, Washington, D.C.

Sartor, James D. Boyd, Gail B.

1972.

Materials which commonly reside on street surfaces contribute substantially to urban pollution when washed into receiving waters by storm runoff. The runoff is similar in many respects to sanitary sewage. Calculations based on a hypothetical but typical U.S. city indicated that the runoff from the first hour of moderate-to-heavy storm would contribute considerably more pollution load than would the same city's sanitary sewage during the same period of time. Runoff was analyzed for the following pollutants: BOD, COD, total and volatile solids, Kjeldahl nitrogen, nitrates, phosphates and a range of pesticides and heavy metals.

contaminants surface street pesticides metals

00022

Disinfection and Odor Control,
Environmental Control Manual, Public Works ,

1972 Edition, p.131

Describes the processes and effectiveness of various chemical disinfection and odor control methods on wastewater effluent. Disinfection and odor control chemicals and various equipment necessary for the application of these chemicals are presented in the article.

disinfection chemical odor control equipment

00023

New Developments in Ammonia Stripping-Part One,
Public Works, Vol. 104, no. 5 p.78.

Gonzalez, John C. Culp, Russell L.

May, 1973

Cost considerations dictate that despite certain problems, the ammonia stripping process should not be overlooked when nitrogen is to be removed from wastewaters. Current practices and recent developments are reviewed.

ammonia stripping

C0024

Fluoridation of a Small Water Plant,
Public Works, Vol.104, no.5, p.102.

Hopkins, Edward Scott, P.E.

May, 1973

This article deals mainly with the fluoridation of Annapolis' water supply from its five deep wells. However, some mention is made of the treatment methods used to remove Iron and Manganese contaminants from the water. The iron removal plant consists of aeration in perforated tray units at the rate of 30gpm per square foot for removal of hydrogen sulfide and reduction of free carbon dioxide followed by flash mixing and mechanical flocculation with alum and lime.

fluoridation wells iron and maganese

C0025

Ozone Disinfection,
Journal AWWA, 64.3.182,

Harris, Weldon C,

March, 1972

The author thinks water utilities should investigate further the possibilities of ozone for water treatment, and he briefly outlines data on an ozone-disinfection program designed for Strasburg, Pa. Article contains ozone generation, cost and distribution data.

ozone disinfection costs

C0026

Arsenic Removal from Potable Water,
Journal AWWA, 63.7.454,

Bellack, Ervin,

July, 1971

In some parts of the US, but mainly in desert areas, the arsenic content of the drinking water supply,if not harmful, is undesirably high. When alternate, unadulterated sources are not available it may be worthwhile to remove the unwanted chemical. This article outlines a method that can reduce arsenic levels to safe amounts at a moderate cost. Ion exchange columns using mesh Alcoa activated alumina utilized and found to be capable of regeneration. Bonechar used on a throw away basis in contact beds was also found to remove arsenic and fluorides.

arsenic ion-exchange cost activated alumina

CCC27

Gamma-Ray Treatment of Tastes and Odors,
Journal AWWA, 63.7.459,

Vajdic, Ann H.

July, 1971

Plant and animal growths can impart an objectionable, musty odor to water containing them. The author discusses the practicality of gamma irradiation to raise the aesthetic standard of drinking water contaminated with an odorous compound produced by a species of actionomycete. Irradiation was performed in a Gammacell 220. Gamma irradiation was found to be equally efficient with waters of both low or high threshold odors.

tastes odors gamma-ray

CCC2E

Destratification Using Air,
Journal AWWA, 63.7.462,

Biederman, W.J. Fulton E.E.

July, 1971

Tests in Waco Reservoir, Texas showed that several advantages can be gained from destratification using compressed air. The

temperature gradients from top to bottom and from month to month-can be decreased, and anaerobic conditions can be lessened. Report covers tests over span of 4 years.

destratification air compressed anaerobic

00029

Modifying Wastewater Treatment Plants to Meet New Standards,
Public Works, Vol.103, no.8, p.80.

Middlebrooks, Joe E., et al,

August, 1972

Various advanced wastewater treatment methods are discussed and cost factors considered.

wastewater treatment costs

00030

The Hydrocyclone for Water Clarification,
Journal AWWA, Vol.65, no16, p.409,

Cobb, T J., et al

June, 1973

The Hydrocyclone, which has found widespread successful use in industry, has considerable potential as a clarifier in water treatment, according to the authors. This article represents a portion of the work accomplished at Oklahoma State University in studying the feasibility of using the hydrocyclone for solids-liquids separation in water and waste-water treatment.

clarification hydro-cyclone

00031

Chemical Conditioning to Control Water Quality Failure in Distribution Systems.
Jawwa Vol.65 no.5, p.348

18

Ghosh, Mriganka M.

May, 1973

Many water systems produce poor water at the tap because the water flowing through the distribution system is too agressive. The author reports on his analysis of systems in Maine and his efforts to improve the character of the water by addition of lime or caustic.

distribution system analysis lime caustic

00032

Continuous Pilot Plant Study of Recycling of Filter Backwash Water, Journal AWWA, Vol.65, no.5, p.355.

Wang, Lawrence K., et al

May, 1973

Recent changes in federal and state requirements have resulted in the classification of backwash water from water- purification plants as a potential pollutant that requires treatment before disposal. This article attempts to determine the effects of backwash-water recycling on the filter operation and the plant effluent quality.

recycling back-wash water effects

00033

Effects of Watershed Development on Water Quality, Journal AWWA, Vol.65, no.5, p.358.

Duane, Richard, J.

May, 1973

Increased urbanization can have many deleterious effects on water quality, all of which must be overcome by water- treatment plants. This article investigates the nature and probable causes of changes in water quality at a site that has been undergoing urbanization over the past few decades.

quality urbanization effects water

00034

Taste Thresholds of Halogens in Water,
Journal AWWA, Vol.65, no.5, p.363.

Bryan, Paul E., et al

The halcgens that are sometimes used as water disinfectants can leave undesirable tastes and odors. In this article a taste panel samples water with various free halogen residuals and interesting statistics are presented.

tastes odor halogens statistics

00035

Apparatus for Concentrating Viruses frcm Large Volumes
Journal AWWA, Vol.64, no.3, p.189

Wallis, Craig, et al,

March, 1972

With the equipment stages described, it is possible to process raw waters at 300gpm, with total virus removal frcm the water and with gcod recovery frcm the virus absorbent. The two virus adsorbents suggested for field use are cellulose membranes and inscluble pclyelectrclyte layers.

virus membranes layers cellulose polyelectrolyte

00036

High-Rate Filtration,
Journal AWWA, Vol.64, no.3, p.203.

Ccrley, W.R. Jcnes, W.H., Kirchman, W.B.

March 1972

High-rate filtration is being used increasingly throughout the world as a result of economic necessity and better understanding of basic processes develcped in recent years. The author discusses experiences and advantages of this type of operation. The purpose of the article is to examine how well the water-treatment plants are working, what the operating problems have been, and the principal advantages of this type cf operatich.

20< filtration high-rate problems advantages

00037

Solubility and Occurence of Lead in Surface Water,
Journal AWWA, Vol.65, no.8, p.562.

Hem, J.D. Durum, W.H.

August, 1973

The data in this article suggest methods of reducing the lead content of drinking water at the water-treatment plant. The article further evaluates the solubility of lead in solutions similar to natural river waters and compares them with lead concentrations that have been determined in recent studies of minor-element contents of surface water.

lead surface solubility reducing methods

00038

Impact of Wastewater Discharges on Surface Water Sources,
Journal AWWA, Vol.64, no.2, p.113.

Vogt, John E.

February, 1972

Upstream wastewater discharges to surface waters can adversely affect downstream water treatment plants. The author presents some case histories in Michigan arising from slugs of inadequately treated discharges.

wastewater discharge surface affect

00039

An Improved Method for Determining Organics by Activated Carbon Absorption and Solvent Extraction - Part 1,
Journal AWWA, Vol.65, no.1,

Buelow, Ralph W., et al,

January, 1973

Increasingly, organics in water are receiving attention.

According to the authors of this article, there has been no apparatus that combines the features of low cost, reliability, portability, and ease of use-until now. This article is the first of a two part presentation. It details the apparatus and describes generally the ramifications of testing. The follow-up to the article will publish complete test procedures.

organics cost apparatus affect

00040

Public Health Aspects of Organics in Water,
Journal AWWA, Vol.65, no.7, p.495

Engerth, Henry J., et al

July, 1973

Very little is known about organics products in water; less is known about their effects, individually or in combination, on man. The authors contend that the situation must be righted before water can be reused for consumptive purposes.

organics rapid-filtration design operation

00041

Municipal Water Systems - A Solution for Thermal Power Plant Cooling,
Journal Awwa, vol.65, no.3 p.175.

Hansen Rodney, G., et al,

March 1973

The authors consider many of the consequences involved in the domestic use of water heated during the heat transfer cycle of power plant operation. One obvious benefit - lower bills for hot water. But there are many drawbacks and the authors consider these can be surmounted.

heated water drawbacks

00042

22<

Virus in Metropolitan Waters: Concentration by Polyelectrolytes,

Freeze Concentration, and Ultrafiltration,
Journal AWWA, Vol.65, no.3, p.200

Rubenstein, S.H., et al

March, 1973

Viruses in natural waters and their importance to public health have become debatable and speculative in the absence of substantive field studies designed to isolate and identify them in metropolitan waters. Here is a report on several techniques investigated as part of a collaborative effort by two agencies.

virus polyelectrolyte freeze concentration

00043

Coagulation, Cake Filtration and Filterability,
Journal AWWA, Vol. 65, no.3, p.203

Regunathan, P., et al,

March 1973

Results of this study indicate that the aggregation of clay particles can occur either by coagulation. or by flocculation, or both, depending upon various factors. Two systems consisting of two different clay minerals and aluminum sulfate have been used to demonstrate the effect of the combined phenomena on cake-forming filtration.

coagulation clay sulfate filtration

00044

Detecting and Treating Organic Taste and Odor Compounds in the Missouri River,
Journal AWWA, Vol.64, no.8, p.505,

Popalisky, J.R Fogge, Franklyn W.

August, 1972

A condition caused by organic pollutants in the Missouri River causes it to look like tea. The dissolved matter creates taste and odor problems. This article details the success of laboratory work to measure the dissolved solids, and relate results to the magnitude of the problem. Also treatments by potassium permanganate and activated carbon and their effectiveness on the pollutants is discussed.

23<

organic pollutants odor activated-carbon

00045

Influence of Temperature on Taste Intensity and Degree of Liking of Drinking Water,
Journal AWWA, Vol.64 no.8, p.511

Pangborn, Rose Marie Bertolero, Linda L.

August, 1972

The degree to which a person reacts to dissolved minerals in water varies with the temperature. The intensity of taste is greatest for water at body temperature and room temperature, and is significantly reduced by chilling or heating. This article details the test carried out to confirm this theory.

taste minerals dissolved test theory

00046

Schistosome Cercariae Removal by Sand Filtration,
Journal AWWA, Vol.63, no.7, p.449.

Bernarde, Melvin A. Johnson, Barry

July, 1971

Most past reports on the use of sand to remove cercariae have been negative. However, sufficient uncertainty shrouded the subject to prompt the authors to try again - this time using a twist rather than employ a vertical filter column, the author turned the column on its side and thereby obtained results that merit additional evaluation.

cercariae sand side

00047

Stream-Velocity Effects on the Heavy Metal Concentrations,
Journal AWWA, Vol.65, no.4, p.275.

24<

Williams, Louis G., et al,

April 1973

The wastes that some big industries dump into rivers and their tributaries often are composed of heavy metals that may impose problems for down-stream water utilities after heavy rains. These wastes and those returned by the utilities to the streams can pose even greater threats to the aquatic life of the water resources. The article discusses the mechanism of transport and its effect on suspended solids and bottom ooze.

heavy-metals sclids transport effect

00048

Effect of Buffer Intensity and Organic Matter on the Oxygenation of Ferrous Iron,
Journal AWWA, Vol.64, no.9, p.590.

Jobin, Robert Gosh, Mriganka M.

September, 1972

Two forms of iron are prevalent in water - the soluble ferrous variety and the insoluble ferric kind. The former can present problems with regard to removal, Moreover, iron can complex with many organic compounds - compounding the problems associated with its removal. This article relates to work performed to expose the extent of the problems and their solution.

organic bound iron

00049

Still Wanted: Economical, Controlled Denitrification,
Water and Waste Engineering, Vol.8, no.6, p.36.

Castaldi, Frank Jerris, John S.

June, 1971

Examines different methods of denitrification in relation to economics and quantity and quality of removal.

denitrification economics

00050

Pretreat Before Deep-Well,
Water and Waste Engineering, Vol.9, no.5, p.C13.

Sadow, Ronald W.

May, 1972

Injection of wastewater below ground is a useful controllable method. However, pretreatment is very necessary to the success of any recharge system. Some method for pretreating and related problems are discussed in the article.

pretreatment deep well disposal

00051

Calcium Phosphate Precipitation at Slightly Alkaline pH Values,
Journal WPCF, Vol.45, no.4, p.620.

Ferguson, John F., et al,

April, 1973

The precipitation of calcium phosphate from wastewater at pH values slightly above 7 offers the prospect of substantial savings in chemical cost over currently used phosphate precipitation processes using lime alum or iron salts. The paper presents theory, methods and applications of the newly developed process.

calcium phosphate removal

00052

Nitrate Removal by Ion Exchange,
Journal WPCF Vol.45 no.4, p.632

Evans, Sheldon,

April, 1973

The presentation deals with the application of the Ducol process to the removal of nitrates from wastewaters. This process is a two-column process wherein the raw water first passes through a bed of strong acid resin and then through a bed of weak base resin. Cations and anions are removed in the first and second beds, respectively. This removal is referred to as demineralization.

26< nitrate removal ion exchange

00053

Chemical Engineering Desk Book, vol 79,no .10,p.61

Characklis, W.G. Busch, A.W.

May 1972

The basic techniques for wastewater treatment by biological,chemical,or physical methods are well understood . However, much can be done to optimize system design and operation through understanding of the chemical stoichiometry and kinetics of the process. These processes are examined in this article

Industrial Wastewater Treatment

00054

Some Aspects of Reverse Osmosis in Treatment of Domestic Sewage, Water and Sewage Works, Vol.119, no.10, p.76.

Besik, F.

October, 1972

The effect of various effluent pretreatment procedures on the efficiency of different reverse osmosis membranes is compared.

reverse osmosis

00055

Bioconcentration of Arsenic by Sludge Mass, Water and Sewage Works,Vol. 119, No. 10, p.95

Johnson, W.F. Hinden, E.

The possibility of biological concentration of toxic trace metals in natural water systems led to a study at the University of Washington of arsenic removal by the biomass in activated sludge treatment systems.

arsenic bioconcentration

00056

Thermal Pollution of Ground Water by Artifical Recharge,
Water and Sewage Works, Vol.119, no.12, p.52.

Sasman, Robert, T.

December, 1972.

Large increases in municipal and industrial ground water pumpage in northwestern Illinois have decreased water levels drastically, approaching 800ft. in areas of heaviest pumpage. Artifical recharge by gravity injection of the deep sandstones is one method by which high water levels can be maintained. One source of recharge water is water used by industries as cooling water. This water being susceptible tc high temperature increases may ultimately increase the temperature of the well water and seriously affect the industrial operations. The article describes the effect of well water temperatures of one industry recharging hot cocling water effluent.

ground water artificial recharge

00057

Virus Removal frcm Wastewater Using Ozcne,
Water and Sewage Works, Vol.119, no.12, p.59.

Panoni, Joseph L., et al,

December, 1972

The virus content cf reused waters is extremely important. The purpose of this investigation was to determine the effectiveness of ozone as a viral disinfectant in secondary effluent wastewater. In field studies utilizing Welsbach ozone pilot plant, viral kill was consistently ccmplete.

ozone virus destruction

00058

Oxidation Pond as an Advanced Treatment Unit,
Water and Sewage Works, Vol.119, no.12, p.56.

Fculds, Jcn M.

December, 1972

A hypothetical system in which the oxidation pond is used as an advanced treatment method is presented.

28

oxiditation pcnd waste treatment

00059

Correlations to Evaluate the Effects of Wastewater Phosphorus on Receiving Waters,
Water and Sewage Works, Vol.120, no.1, p.48.

Fitzgerald, G.P., et al,

January, 1973

Nutrient surveys of the Sahara and Rock Rivers found phosphorus in excess of that required by the existing algae and aquatic needs upstream from the effluents of the Cities of Strongton, Oregon and Madison in Wisconsin.

receiving waters nutrients

00060

Wastewater Treatment Properties of Fe(11) and Fe(111) Compounds,
Water and Sewage Works, Vol.120, no.2, p.54.

Chung, S,K. Bhagat,

February, 1973

Secondary Biological treatment of wastewater does not effectively remove phosphorus and nitrogen. This article investigates the feasibility of using Fe(11) and Fe(111) compounds to remove the phosphorus. The iron salts used in the study provided significant removal of phosphorus in adddition to the removal of COD, and suspended solids. The degree of treatment can be controlled by altering chemical dosages. Fe(11) provided comparable results with Fe(111). However, Fe(11) proved unsatisfactory as a coagulant under aeration conditions.

nutrient removal wastewater

00061

Filtration of Effluent from A Biological Chemical System.
Water and Sewage Works, Vol.120, no.2, p.66.

Ripley, P.G. Lamt, G.L.

February, 1973

The results of an investigation into the feasibility of an optimum conditions for use of a deep-bed sandfilter for polishing effluent from a combined biological chemical waste- water treatment process are discussed.

sand filtration wastewater

00062

Two Methods for Algae Removal from Oxidation Ponds Effluent,
Water and Sewage Works, Vol.120, no.3, p.66.

O'Brien, W.J. Turney, M.D. Martin, D.M.

March, 1973

Oxidation ponds provide a reliable method for achieving secondary treatment at minimum cost to the small community. However, there has been a rising concern over the quality of the effluent discharged from these ponds. The problem stems from the presence of algae cells which render routine disinfection practices inadequate. Two methods of algae removal - submerged rock filter, a process by which the rocks provide an area for biological growth, and upflow fly ash filter, a process of organic contaminants removal by fly ash - have been developed for the small communities with their limited resources in mind.

algae removal oxidation ponds

00063

Nitrogen and Phosphorus Uptake by Chlorella Pyrenoidosa Sewage Treatment Processes,
Water and Sewage Works, Vol.120, no.3, p.76.

Michel, Thomas M. Michel, James L.

March, 1973

The use of algae has been proposed as a biological means of nitrogen and phosphorus removal from wastewater, but a limited understanding of the biological processes involved in eutrophication has curtailed large-scale application of the process. The article evaluates the effectiveness of sewage lagoons, stabilizing and oxidation ponds, and other secondary treatment systems, The rate and

30<

efficiency of phosphorus assimilation by the algae were studied.

nutrient removal algae

00064

Phosphorus Removal from Wastewaters: A Cost Analysis.
Water and Sewage Works, Vol.120, no.3, p.82,

Kumar, Inder Jit Clesceri, Nichclas L.

March, 1973.

An analysis of the cost of phosphorus removal from wastewater is presented. The authors purpose was to emphasize that phosphorus is amenable to removal by chemical treatment to any degree desired and that no sophisticated plants are required for this purpose. The approximate cost of reducing the influent phosphorus 80 per cent would range from 3.5 cents/1000 gallons to 8 cents/1000 gallons depending on plant size and method of treatment.

phosphorus removal costs

00065

A Study of Treated Wastewater Chlorination,
Water and Sewage Works, Vol.120, no.4, p.68.

Holm, John D.

April, 1973

In a seven month test of a wastewater treatment plant in San Antonio, Texas, chlorination apparently caused an increase in suspended solids concentration, reduction in 5-day BOD and little change in TOD or ortho-phosphate concentration.

chlorination waste water

00066

Water Supply and Treatment in Two Regions of Saudi Arabia,
Water and Sewage Works, Vol.120, no.5, p.84.

Shaheen, E.I.

May, 1973

The water systems in Riyadh and the eastern region of Saud Arabia are dependent on groundwater resources for their supply. However, the systems are completely different. Riyadh has a comparatively sophisticated water treatment system which includes coolers, sedimentation, filtration, chlorination, etc. The only treatment in the eastern province is direct chlorination, however the water is of better quality in spite of a the high oncentration of dissolved solids. A conventional water treatment plant and a desalination plant are being built to alleviate this problem. In addition to reducing salinity, it will serve as a future pure water supply.

water supply and treatment

00067

Improvement in Terminal Disinfection of Sewage Effluents,
Water and Sewage Works, Vol.120, no5, p.57.

Kruse, C.W. et al,

June, 1973

Full scale sewage treatment plant studies show that terminal disinfection of virus and coliform bacteria can be increased through improved chlorine-sewage mixing and acid feed without increasing chlorine dosage.

bacterial wastewater

00068

High Rate Absorption-bio-oxidation of Domestic Sewage,
Water and Sewage Works, Vol.120, no6, p.68.

Besik, F.

June, 1973

An experiment to treat wastewater in a system combining absorption and bio-oxidation produced results which indicate that with further development such a system could drastically reduce treatment costs.

adsorption bio-oxidation

32< 00069

Inorganic and Organic Phcsphorus Distribution in Domestic and Municipal Sewage,
Water and Sewage Works, Vol.120, no6. p.,2

Haung, P.M. Hwang, C.P.

June, 1973

Fractional distribution of various sizes and forms of phosphorus in wastewater is examined as a key to understanding the phosphorus removal potential of conventional treatment processes.

phosphorus wastewater

00070

An Evaluation of Various Mixing devices for Dispersing Ozone in Water,
Water and Sewage Works, ref.no.1973, p.R6.

Nebel, Carl, et al,

Effective use of ozone in water is dependent upon two factors: the rate cf reacticn cf the ozone with the species in the solution and the mass transfer of ozone from the gaseous to the liquid phase where reaction can occur. Mass transfer can be optimized by employing an efficient mixing device. The purpose of this study is to investigate alternate methcds cf mixing.

ozcne water treatment

00071

Advanced Wastewater Treatment Techniques for Removing Nitrogen and Phosphorus,
Water and Sewage works, Ref.no.1973, p.R15.

Evers, R. H.

Nitrogen and phosphorus in wastewater are generally recognized as problems since these nutrients individually or collectively may stimulate the growth cf an objectionable quality of aquatic plants. The removal of nitrogen and phosphorus frcm wastewater is complicated since most biclogical waste treatment processes do not remove these nutrients to any substantial extent. The chemical process described in the article have been designed to alleviate this removal problem. The systems described for nitrogen removal are: ammonia stripping, selective icn exchange, breakpoint chlorination and ion exchange

nutrients wastewater

00072

Water Reuse Through Advanced Wastewater Treatment,
Water and Sewage Works, ref.no.1973, p.R60.

Mcdonnell, Gerald M.

The article describes the processes utilized by the WSSC'S model AWT plant at Piscataway. The plant was developed as a joint venture by WSSC and the Federal Water Quality Administration to investigate the possibility of water reuse through advanced wastewater treatment systems. The following processing concepts were utilized; lime as a coagulant in removing phosphorus and organic suspended solids, the development of a process to recover this lime for reuse the development of activated carbon columns to remove taste, odor, color, etc., and the development of a process to regenerate the carbon for reuse.

water resuse wastewater

00073

Full-Scale Mineral Addition Lebanon, Ohio,
Water and Sewage Works, Ref. no.1973, p.R79.

Feige, Walter A. Berg, Edeard L.

The city of Lebanon, Ohio, and U.S. EPA'S National Environmental Research Center at Cincinnatti, Ohio, conducted a study at the Lebanon Sewage Treatment Plant on full scale mineral addition. The main objective of the study was to determine the technical and economical feasibility of raw wastewater chemical clarification with the use of existing facilities at the plant so that the effluent would be a suitable feed for carbon treatment. The two inorganic coagulants used were liquid alum, and a ferric chloride solution and a weak anionic polyelectrolyte aided flocculation and sedimentation.

mineral addition wastewater

00074

Cyanide - An Assessment of Alternatives for Water Pollution Control,
Water and Sewage Works, Ref. no. 1973, p.R95.

Cheremisinoff, Paul N. Habib, Lousul H.

An overview of how and when cyanides occur in wastewater, their toxic effects and removal techniques.

cyanide wastewater

00075

Iodine-129 in the Environment Around Nuclear Fuel
USEPA,

Magno. P.J. et al,

October, 1972.

The specific activity of iodine-129, i.e., the ratio of the activity of iodine-129 to the weight of stable iodine was measured in the environment around the Nuclear Fuel Services' reprocessing plant, West Valley, N.Y., during the summer of 1971.

iodine 129 radwastes

00076

Municiapl Water Treatment with Polyelectrolytes,
Public Works, p.80

Kleber, J.P.

October, 1973

Although synthetic polyelectrolytes will not cure all problems in the clarification of water, they have become increasingly beneficial in a number of application. The author contends that undoubtedly, the advantages of using polyelectrolytes will become more apparent with time and experience.

polyelectrolytes

00077

Water Treatment for Industrial and other Uses second Edition . Report of the Secretary's Commission on Pesticides and their Relationship to Environmental Health. .U.S. Department of Health, Education and

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Welfare.
U.S. Govt. Printing cffice, Washington D.C.

Nordel, Eskel

December, 1969

C0078

Study and Interpretation of the Chemical Characteristics of National Water second edition.
Geological Survey Water-Supply Paper U.S. Government Printing Office Washington D.C.

Hem, John D.

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Practical Guide to Water Quality Studies of Streams,
U.S. Department of the Interior, Federal Water Pollution Control Administration CWR 5. U.S. Government Printing Office, Washington D.C.

Kittrel, F.W.

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Groundwater Resource Evaluation.
McGraw Hill, New York

Walton. William C.

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Advanced Wastewater Treatment, Manual of Instruction for Water

Treatment Plant Operators.
Van Nostrand Reinhold Company, New York. New York State Department of Health, Health Education Service New York.

Culp. Russell Culo, Gordon L.

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Water-Resources Engineering,
Mc-Graw-Hill Book Company, N.Y.

Frarzini, J.E. Linsley R.K.

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Elements of Water Supply and Waste-Water Disposal,
John Wiley & sons Lcrdon,

Fair, G.M. Geyer J.C.

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C0084

Environmental Protection,
McGraw-Hill Bock Company,

Chanlett, Emil,

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Water Quality in Reservoirs:
A Compilation of Published Research Papers, Public Health Service Publication no.1930 U.S. Government Printing Office,

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Symons, J.M.

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Water supply Engineering,
McGraw-Hill Book Company Inc., N.Y.

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Water Supply and Pollution Control,
International Textbock Co., Scranton, Pa.

Clark, J.W. and Viessman W. jr.

1969

00088

Water and Wastewater Engineering Volume 11, Thomson, published by Thomson, P.C. Box 50160,
John Wiley & Sons, Inc. N.Y. Agriculture Chemicals-Book 1 Insecticides, W.T. Indianapolis, Ind. 46250, p.7 Insecticide & Fungicide Handbockfor Protection, issued by British Corp Protection Council, edited by Hubert Martin, published by Blackwell Scientific, Oxford & Edinburgh, p.353

Fair, G.M. Geyer, J.C. Okun, D.A.

1966 1972 1969

00089

Water Quality Criteria second edition, sample,
The Resources Agency of California State water Quality Control Board, Pub. no3-A

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Mckee Wolf

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00091

William R., Chem. Aprogr. Symposium ser. nc.78,63, p. 223

1967.

The removal of nitrogeneous materials from wastewaters is reviewed. Removals in both existing treatment plants as well as tertiary treatment methods are discussed with denitrification, algae incorporation, and air stripping receiving particular attention.

nitrogeneous materials

00092

Water Reclamation with Granular Activated Carbon.
Progr. Symposium Ser. no. 78,p.185

Cooper, J.C. and D.C. Hager, Chem. Eng.

1967.

00093

Conservation of water by reuse in the United States,
Prcgr. Symposium, Ser. no.78, 63,p.74

Rickles, Robert N.,Chem. Eng.

1967.

00094

Pct Permits Grcundwater Replerishment,

Public Works, Vol.104, no.5, p.105

May, 1973

Nassau County, on Long Island, New York, uses physical-chemical treatment as a tertiary process prior to experimental groundwater recharge operations. The effluent from the Bay Park Wastewater Treatment Plant at Far Rockaway was selected as the source of raw water for treatment for injection. The article goes on to describe the tertiary treatment processes used for removal of solids, BOD and phosphate.

groundwater recharge

C0095

Memphis Adds a Sixth Water Treatment Plant,
Public Works, vol.104, no.58 p.73.

Allen, Lorin b.

May, 1973

A new 15 mgd iron removal plant is part of a long range water improvement program planned to serve all areas of Shelby County Tennessee. The existence of an abundant groundwater source precludes dependence on the muddy Mississippi as a water source. Water taken from the wells although containing no harmful bacteria has an excess of dissolved iron and free carbon dioxide, sufficient to justify treatment. In all respects the water is of highly desirable quality. The treatment process consists of aeration and filtration along with the addition of chlorine and fluoride. The processes are described in detail.

iron removal

C0096

Denver Converts to Liquid Alum,
Water Works Digest, Public Works, Vol.103, no.4.

Jacobson, Alvin R., PhD.

April. 1973

The availability of liquid alum made it possible to convert the Moffat and Marston water treatment plants serving Denver, Colorado, to coagulation by liquid alum. City officials understood that a saving of $35,000 annually could be realized when the conversion from

use of the dry to liquid alum was feasible.

coagulation liquid alum

00097

Physical-Chemical Techniques for Treatment of Raw Wastewater, Public Works, p.56.

Culp,Gordon L. Shuckrow, J.A.

July, 1972

A review of the status of physical-chemical treatment methods and a description in various pilot and full-scale projects. Several recent studies indicate that physical-chemical treatment of raw wastewaters offer performance advantages over biological treatment, and under some conditions may also offer economic advantages. All approaches investigated used chemical coagulation and settling for removal of suspended solids and, in some cases, removal of phosphorous. Both granular and powdered activated carbon are being used for removal of soluble organics.

wastewater treatment

00098

Chemical Precipitation for Phosphate Removal, Environmental Waste Control Digest, Public Works, Vol.103, no.7, p.88

July, 1972

Following a three-month test of the use of aluminum sulfate as a chemical precipitant, the city of Sandusky, Ohio, announced that 90 percent of the phosphates are being removed at its recently established sewage treatment plant. Use of the chemical has also contributed to a sharp reduction in BOD and suspended solids in the plant effluent

phosphate removal

00099

Water Brought to Highway Rest Area the 'Hard' Way,

41<

Public Works, Vol.103, no.7, p.78

July, 1972

West area in an arid area secured water from a deep well but found the supply to be highly mineralized. Reverse osmosis treatment solved the problem.

00100

State of the Art of Water Filtration,
Journal AWWA, Vol.64, no.10, p.662.

October, 1972

The theoretical and practical worldwide investigations of rapid filtration of water that are reviewed in this article range from the design, operation, and physical aspects of filtration mechanisms to detailed recommendations for further research.

00101

Industrial Wastewater Treatment, Water Pollution Control,
Chemical Engineering Desk Book, Vol.79, no.10, p.61. Chemical Engineering, Vol.79, no.10, p.65.

May ,1972 May, 1972

The basic techniques for wastewater treatment by biological, chemical, or physical methods are well understood. However, much can be done to optimize system design and operation through understanding of the chemical stoichiometry and kinetics of the process. These are examined in this article. Prime tools for wastewater treatment are sedimentation, biological processes and chemical treatment. The challenge of the 70's is to develop better ways of applying fundamental principles. Biological, chemical and thermal pollution are discussed in this article.

00102

Diatomile Filter Equipment Evaluation and Design Guide Lines
A report for Consulting Engineers and Plant Operators, prepared by AWWA Committee. 7110P on Diatomite Filtration. Unpublished Report contains detailed information on cost comparisons between diatomite filtration and rapid sand filtration as well are removal information

42

for iron, manganese, taste, odor, and turbidity.

00103

Ground Water
American Water Works Asscciation Manual of Water supply Practices, New York,

1973.

00104

The American Water Works Association, Inc.
Water Quality and Treatment - A Handbook of Public Water Supplies third edition, Mc Graw Hill, New York,

1971

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U.S. Department of Health, Education, and Welfare - Public Health Service
Public Health Service Drinking Water Standards U.S. Government Printing Office, Washington D.C.

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Activated
Arsenic Rezcval frcm Potable Water,
Journal AWWA, 63.7.454,
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Activated-carbon
Detecting and Treating Organic Taste and Odor Ccmpounds in the Missouri River,
Journal AWWA, Vol.64, nc.8, p.505,
CCC45
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Adsorption
High Rate Absorption-bio-oxidatien cf Dcmestic Sewage,
Water and Sewage Works, Vol.120, no6, p.68.
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High-Rate Filtration,
Journal AWWA, Vol.64, nc.3, p.203.
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Control of Reservcir Euthrophication.
Journal AWWA, 65.4.268,
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Affect
Impact of Wastewater Discharges on Surface Water Sources,
Journal AWWA, Vcl.64, nc.2, p.113.
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An Improved Method for Determining Organics by Activated Carbon Absorption and Solvent Extractien - Part 1,
Journal AWWA, Vcl.65, no.1,
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Air ccmpressed
Destratification Using Air,
Journal AWWA, 63.7.462,
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Nitrogen and Phosphorus Uptake by Chlorella Pyrenoidosa Sewage Treatment Processes,
Water and Sewage Works, Vol.120, no.3, p.76.
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Algae removal
Two Methods for Algae Removal from Oxidation Ponds Effluent, Water and Sewage Works, Vol.120, no.3, p.66.
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Alumina
Arsenic Removal from Potable Water, Journal AWWA, 63.7.454,
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New Developments in Ammonia Stripping-Part One, Public Works, Vol.104, no.5 p.78.
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Destratification Using Air, Journal AWWA, 63.7.462,
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Mercury in Drinking Water Supplies Journal AWWA, 64.1.60
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Chemical Conditioning to Control Water Quality Failure in Distribution Systems.
Jawwa Vol.65 no.5, p.348
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An Improved Method for Determining Organics by Activated Carbon Absorption and Solvent Extraction - Part 1, Journal AWWA, Vol.65, no.1,
00040 Page 15

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Growth of Desalting Technology - Studies and Applications, Journal AWWA. 64.11.701
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Arsenic Removal from Potable Water, Journal AWWA, 63.7.454,
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Bioconcentration of Arsenic by Sludge Mass,
Water and Sewage Works,Vol. 119, No. 10, p.95
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Artificial recharge
Thermal Pollution of Ground Water by Artifical Recharge,
Water and Sewage Works, Vol.119, no.12, p.52.
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Continuous Pilot Plant Study of Recycling of Filter Backwash Water,
Journal AWWA, Vol.65, no.5, p.355.
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Water and Sewage Works, Vol.120, no5, p.57.
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Calcium Phosphate Precipitation at Slightly Alkaline pH Values,
Journal WPCF, Vol.45, no.4, p.620.
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Journal AWWA, 64.3.176
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Chemical Conditioning to Control Water Quality Failure in
Distribution Systems.
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Journal AWWA, Vol.63, no.7, p.449.
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Special Lake Water Treatment Problems,
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Advanced Wastewater Treatment fcr Removing Nitrcgen
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Still Wanted: Economical, Controlled Denitrification,
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Journal AWWA, Vol.65, no.4, p.275.
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